Waste Management

Processing agricultural commodities creates mountains of wastes. They include corncobs and feathers, peelings and pits, straw and hulls, and manure and slaughterhouse offal. Producers and processors of farm products must either find practical uses for these billions of tons of wastes or dispose of them in ways that do not pollute the soil, water, or air. All four regional research centers have contributed to solving the vexing problems of agricultural waste management, and they have occasionally found ways to reduce nonagricultural pollution as well.

Corncobs are an example of a nonpolluting waste product that just keeps piling up. Corn is America's biggest row crop, and every ear of corn has a cob. Many, many uses have been found for corncobs, including corncob pipes, but one of the most unusual was discovered during World War II. The Northern laboratory at Peoria, in cooperation with the U.S. Navy, developed a method for cleaning the Navy's airplane engines by air blasting them with ground corncobs.

Each engine had to be overhauled after 800 hours of flying time to remove carbon and oil deposits that built up in cylinders and on pistons. The Navy first tried scouring them with corn grits in sand-blasting machines, but NRRC and Navy maintenance people soon found that a mixture of 60 percent ground corncobs and 40 percent unground rice hulls lasted 10 times longer than corn grits. The soft cob particles cleaned the carbon, oil, and scale from the engines without damaging the metal parts, and they could be used repeatedly until they finally turned to powder. Fifty new plants were built during the war to grind corncobs for this purpose, and soft-grit blasting was soon adopted for a number of industrial uses.

Another wartime use of corncobs, as well as of oat and cottonseed hulls, was in making an amber-colored liquid called furfural. The chemical had a number of pre-war uses in industry, including refining lubricating and diesel engine oils and making resins and plastics, but the market was not expanding very fast. During World War II, however, with foreign supplies of natural rubber cut off, furfural was found to be one of the best chemicals for purifying butadiene, used in making synthetic rubber. NRRC researchers developed a practical way to make furfural from the carbohydrates in corncobs, transforming them into one of the raw materials used in a new government-built furfural plant at Memphis.

Typical corn production today yields about 35 billion tons of corncobs every year, most of which are plowed back into the soil. But thanks to research, a substantial number also find their way into industrial paper, hand soap, animal feeds and bedding, sweeping compounds, and plastic fillers. Ground corncobs are even used to clean carpets and furs.

The Northern laboratory . . . developed a method for cleaning the Navy's airplane engines by air blasting them with ground corncobs.

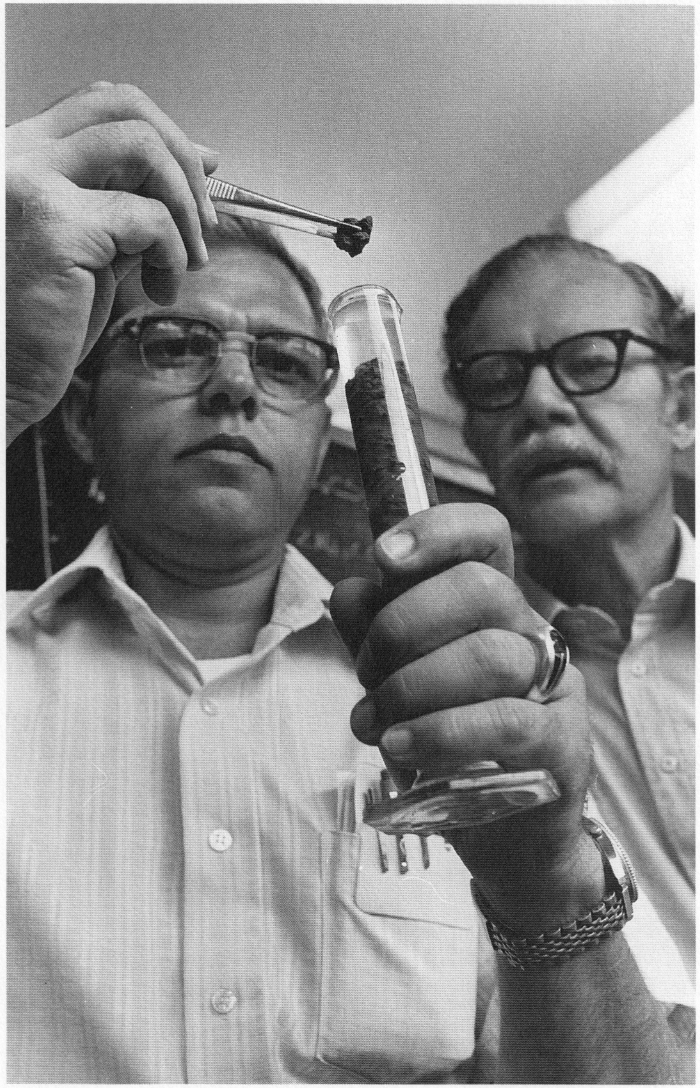
Feathers were another waste product that tended to pile up fast, particularly with postwar centralization of the poultry industry. Feathers were a liability for poultry processors, who had to pay to dispose of them. After looking at several alternatives, Western researchers decided that their most practical goal would be to convert the wet, dirty feathers into a usable, salable product.

The best answer, they found, was to pressure-cook the wet feathers in rotating dry cookers, commonly found in rendering plants. Heating decreased the tensile strength and elasticity of the feathers, allowing them to be ground into a meal for fertilizer. Further research upgraded the product to a protein feed supplement. Within a few years, about 80 percent of the feathers from poultry processing plants was being converted to a high-protein feed supplement. Instead of costing processors $5 a ton for disposal, feather meal was soon an asset, selling for $100 a ton.

One of the most troublesome problems of agricultural wastes was experienced by the dairy industry, and immediately after the war, research began at the Eastern lab to find some answers. Water used for sanitation and cooling in dairy plants had 3 to 4 times the polluting strength of raw sewage. More and more municipal sewage plants in the late 1940's either charged dairies a premium price for handling their wastes or refused to accept them at all. In rural areas, untreated milk plant wastes were often discharged into small streams, where they depleted the water's oxygen supply and caused serious pollution.

In 1948, a dairy industry committee asked the ERRC to find an inexpensive way to treat dairy wastes and wash water by aeration. After several years of research, researchers developed a laboratory-scale process based on their analysis of the biological-oxygen demand of dairy wastes. It was a simple, two-stage disposal system that used both aeration and bacteria to oxidize the organic wastes. Under a government contract, engineers at Pennsylvania State University translated the ERRC findings into the design of a full-scale dairy waste aeration unit. The pilot plant proved effective and economical. Dairies, some of them plagued by State and civil actions, soon built similar plants. Many discovered that as a result, they were able to handle several times as much milk. The continuous digestion process for treating dairy wastes is widely used today, not only by dairies but also by citrus, canning, pharmaceutical, paper, and other industries. (Whey, another vexing waste product of the dairy industry, is discussed in a separate chapter.)

Meanwhile, the Western center in California found a way to convert waste from pear canneries into molasses and dried pulp to feed cattle and sheep. The process, which also worked with cannery wastes from peaches, grapes, and tomatoes, was similar to one developed earlier in Florida to utilize citrus industry wastes. In other research, a Western lab chemist found a way to recover more lanolin from wool after washing, or scouring, it. The process not only produced more lanolin for industrial uses, but it resulted in much less stream pollution from wool grease.



One use for artificial gravel, made by combining cellulose xanthate with soil, is to surround perforated drainage tubes to prevent clogging of holes by fine soil particles. WRRC researchers Earl Hautala (left) and Emory Menefee developed xanthate from waste cellulose products.

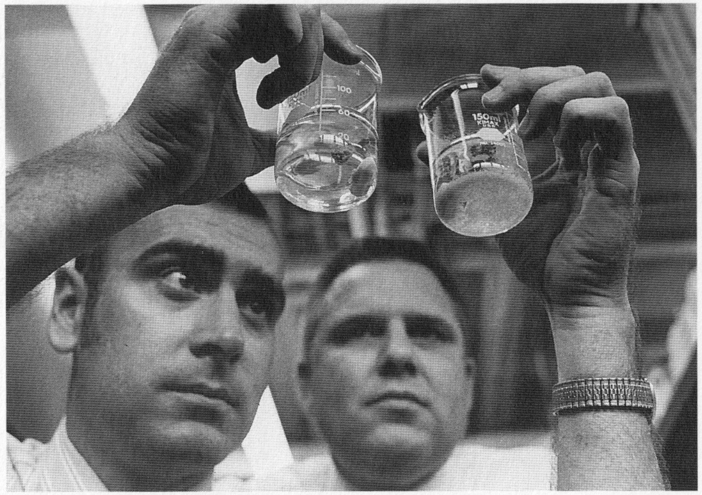
In the 1960's, the Western center set out to find better ways to peel fruits and vegetables for processing. Aims of the research were less waste and reduced stream pollution. The peeling method then in use by the industry began with softening the skins with steam or a lye solution, followed by high-pressure sprays of water to flush away the peels. Tough new State and Federal antipollution regulations, however, made it imperative for the processing industry to come up with new peeling methods that used less water and fed fewer pollutants into waterways.

A patented new method from WRRC scientists removed peels and skins without water. Instead, so-called dry scrubbers rubbed off the lye-softened peels. One type of apparatus consisted of spinning rubber-tipped rolls that abraded the peel from the product without damaging the underlying edible tissue. It worked well with potatoes and other root crops. Another WRRC invention fed the produce onto a bed of rotating rubber disks that wiped off the skins. It proved effective for soft fruits, such as cling peaches, apricots, and pears, and it was later modified to peel tomatoes.

A new compound from cornstarch was found to remove heavy metals from polluted water.

The new techniques, which won widespread recognition for the inventors, enabled processors to comply with antipollution rules. They also allowed recovery of much more of the peel and trim in the form of solids, which was then converted to cattle feed.

Within a few years, Western lab scientists developed yet another way to remove tomato peels. Tomatoes were first heated with steam to loosen the peels, then cooled quickly in a water bath. The quick heating and cooling sequence was repeated three times, after which the skins were removed mechanically. The water used in this process was recycled, and more of the edible pulp of the tomatoes was preserved for canning.



Peoria researchers Robert Wing (left) and Charles Swanson examine beakers containing starch xanthate and water contaminated with mercury. The mercury compounds have been precipitated, and the recovered mercury can be reused. Starch xanthate can also recover other heavy metals.

In several instances, the regional laboratories found ways to use surplus agricultural materials to fight pollution from mining and heavy industry. At the Northern lab, scientists found that a compound made from cornstarch (or any other starch; see p. 120) could be used to recover mercury and other heavy metals from polluted water. Insoluble starch xanthate (ISX), when added to mercury-laden waste water, attracts the heavy metal, combines with it, and carries it to the bottom of the tank, leaving a clear filtrate behind. The starch xanthate process also works well with lead, silver, chromium, cadmium, copper, lead, and nickel.

At the Southern lab, researchers learned that several compounds being tested as durable-press finishes had an affinity for metal salts. Cotton treated with these chemicals can be used as a trap for waterborne heavy chemicals. The special fabrics can be regenerated for repeated use. In tests, they proved capable of reducing the mercury content of contaminated water below the level permitted in drinking water.

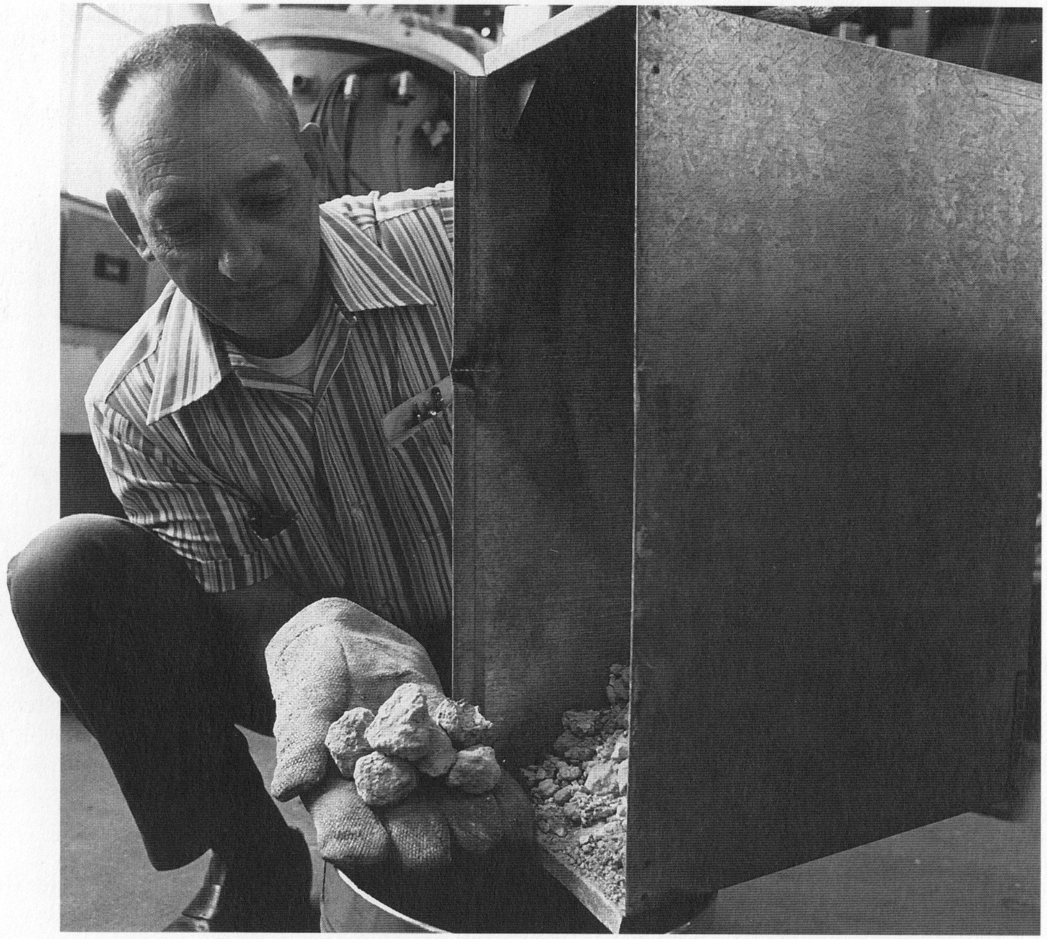
Researchers at the Western lab tested a wide range of agricultural materials and byproducts for their ability to remove heavy metal salts and radioactive metals from water. Studied for their binding action were wool and feathers, bark, orange peels, rice straw, plum pit shells, peanut and rice hulls, and sugarcane bagasse. Redwood bark and other materials high in tannin proved effective in binding the metallic ions in polluted water. The metals could then be reclaimed for reuse.

Adding sewage sludge to barren coal mine wastes makes it possible to grow healing vegetation.

Another waste disposal challenge in the early 1970's confronted California's pickle and olive packers. They were releasing millions of gallons of pickling brine into waterways each season, and proposed legislation was about to limit the dumping of saline liquid waste. Engineers at the Western lab developed a practical method for reclaiming the salt from the brine. The heart of the process was a submerged combustion evaporator that reduced the salt and other products in the used brine solutions to a slurry. Organic contaminants were incinerated, remaining carbon was filtered out, and the salt was ready for reuse in the next cucumber and olive season. A pilot plant built at the California laboratory worked so well that a private manufacturer began making and marketing a brine disposal and salt recovery system based directly on the WRRC process.

Occasionally, the regional labs have found uses for wastes that help solve other environmental problems. One of the most serious is soil erosion from the action of wind and water. Erosion not only depletes the productivity of the soil, but eroded soil is the number one pollutant—in volume—of America's streams and rivers. In an effort to slow soil losses, Western lab researchers have developed an inexpensive soil amendment. Cellulose xanthate, made through a simple chemical treatment of wheat or rice straw, has the ability to bind soil particles together. When a small amount of a cellulose xanthate solution was sprayed on soil in a test pilot, it reduced soil erosion to less than one-half of 1 percent of that in untreated soil plots.

At the Northern center, researchers found that adding sewage sludge from municipal treatment plants to barren coal-mine



In Western lab, engineer Everett Durkee removes recycled salt left from olive processing after contaminants are incinerated. Salt can be reused during next olive season.

wastes makes it possible to grow healing vegetation where not even a weed would grow before. The surface-mine reclamation study was carried out by NRRC in cooperation with the Greater Peoria Sanitary District.

In other NRRC research, it was found that encapsulating the herbicide atrazine in cornstarch sharply reduced leaching of the chemical down through the soil, where it could reach ground-water and contaminate it. Studies of a cornfield where atrazine had been applied for 8 years showed that the cornstarch jackets cut leaching losses of the chemical from 35 percent to less than 1 percent.

In the mid-1980's, with oil spills on the increase, an NRRC chemist reported that crop residues might be used to remove small amounts of oil emulsified in water. Straw from small grains and cornstalks, cobs, and husks can be treated with inexpensive chemicals to balance their affinity for oil with their affinity for water. The patented treatment causes the residue fibers to swell and separate in water to provide maximum surface area for oil removal.

Meanwhile, researchers at the Southern lab discovered a way to liquefy waste solids from catfish processing plants for a variety of uses. The heads, skins, and viscera of catfish make up from 35 to 40 percent of the weight of a whole fish, and these wastes add up to several million pounds a year. SRRC scientists found that small amounts of formic acid act as an inexpensive catalyst to activate powerful enzymes in the gut of catfish. These proteolytic enzymes can turn the wastes to liquid in just a few hours. After the bones are filtered out, the liquid can be sold for use as a home or nursery fertilizer, as a high-protein feed supplement, or as a fish flavor for catfood.